## Distributed Energy Resources and Microgrid Modelling

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Natural Gas Propane Liquid Fuels

### Motivation and Objective

**Complex problem:** Optimized customer adoption patterns of Distributed Energy Resources (DER) in microgrids and buildings

**DER-CAM:** Development of the Distributed Energy Resources Customer Adoption Model tool

### DER-CAM

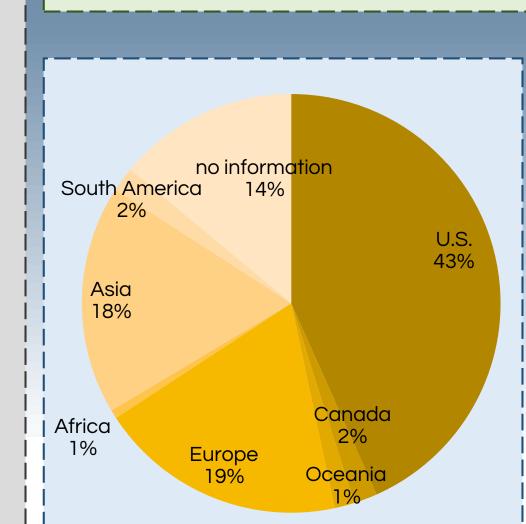
# DER-CAM+ DECISION SUPPORT TOOL FOR DECENTRALIZED ENERGY SYSTEMS TOPOLOGY | ANALYTICS | PLANNING | OPERATIONS

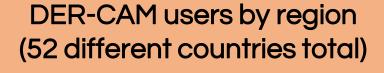
#### Two main versions:

- Investment and Planning DER-CAM: Optimal sizing and placement of energy supply solutions for microgrids, used in microgrid conceptual design and feasibility study
- Operations DER-CAM: Optimal dispatch of microgrid assets, used in supervisory microgrid control

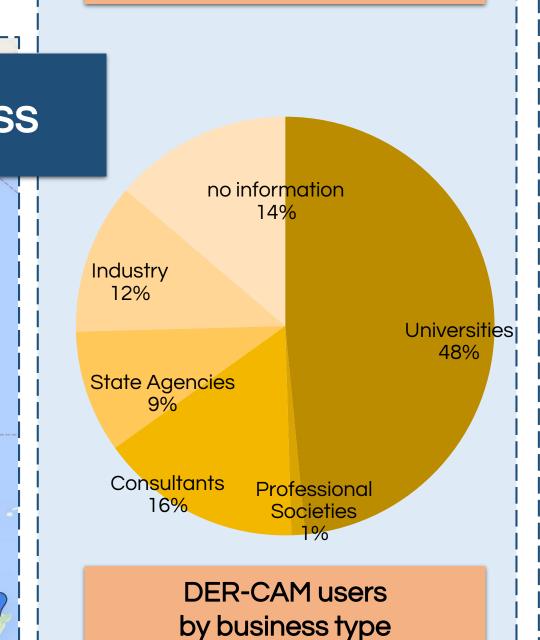
Wide range of technologies: including fuel cells, conventional distributed generators, combined heat and power, renewable generators, electric vehicles, conventional storage, advanced storage, building retrofits

Multi-energy microgrid modeling: electricity, heating, cooling end-uses









 2013 US Presidential Early Career Award for Scientists and Engineers awarded by President Obama in 2016

ELECTRICITY

**DIRECT UTILIZATION** 

Cold Storage



- Partnership with prestigious universities and companies
- 80+ peer-reviewed and 60 other publications

Team Success

THE WHITE HOUSE

Complex

energy flow

in microgrids

Choice of End-Use Equipment

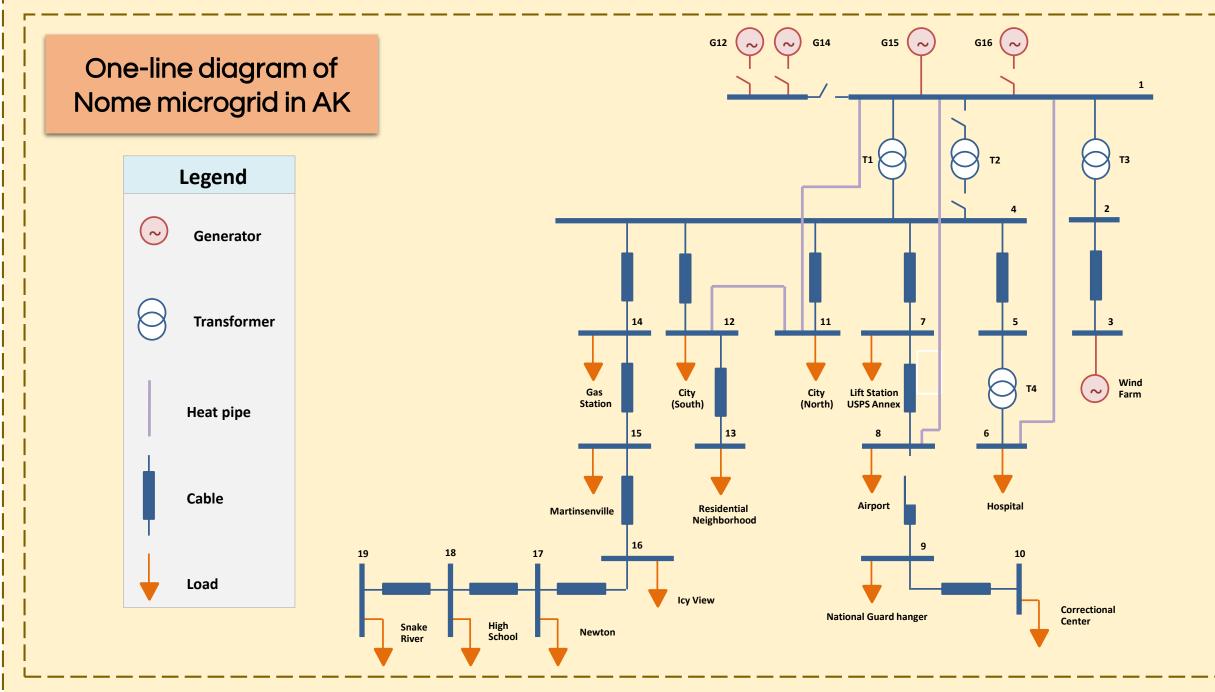
MICROGRID

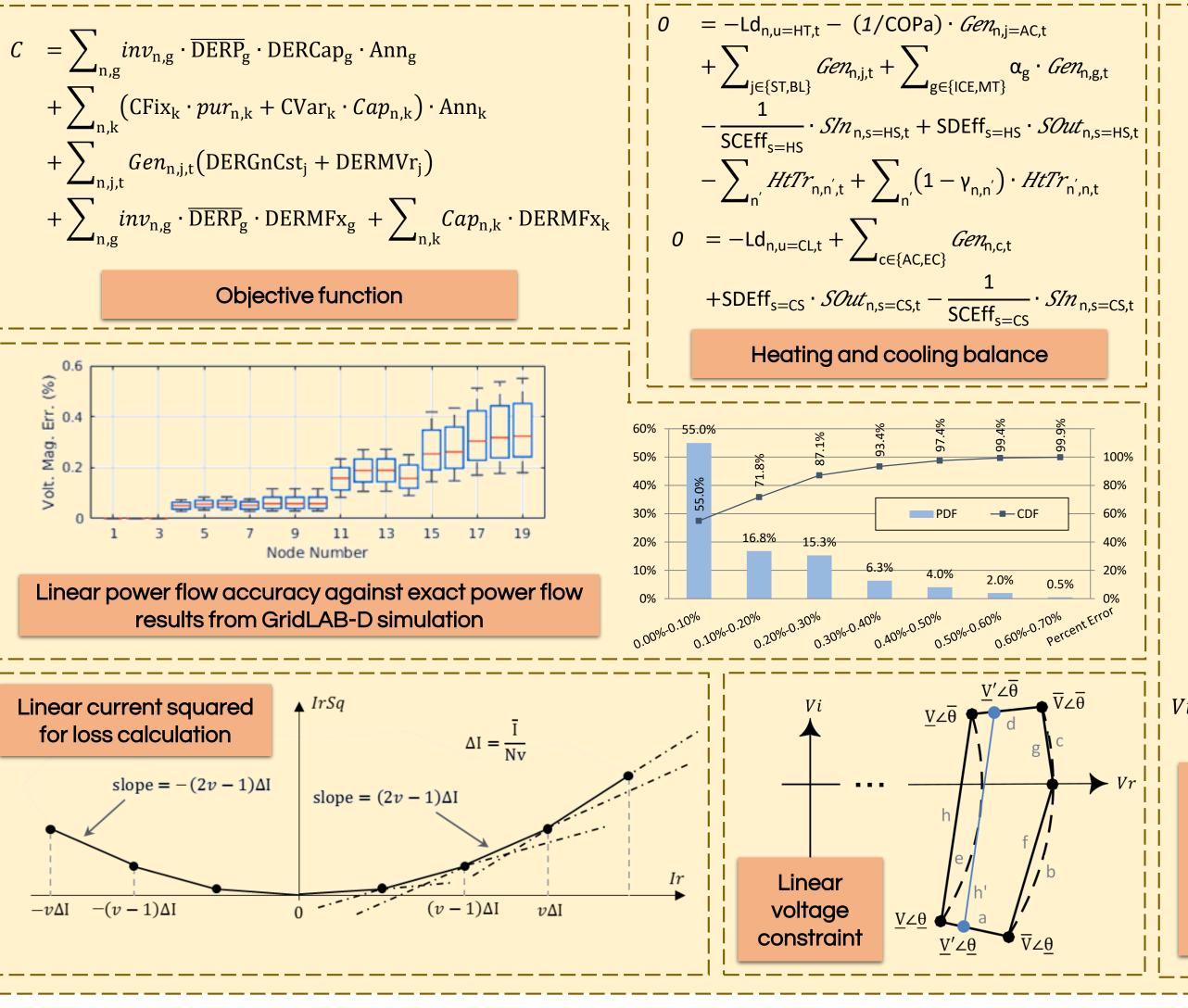


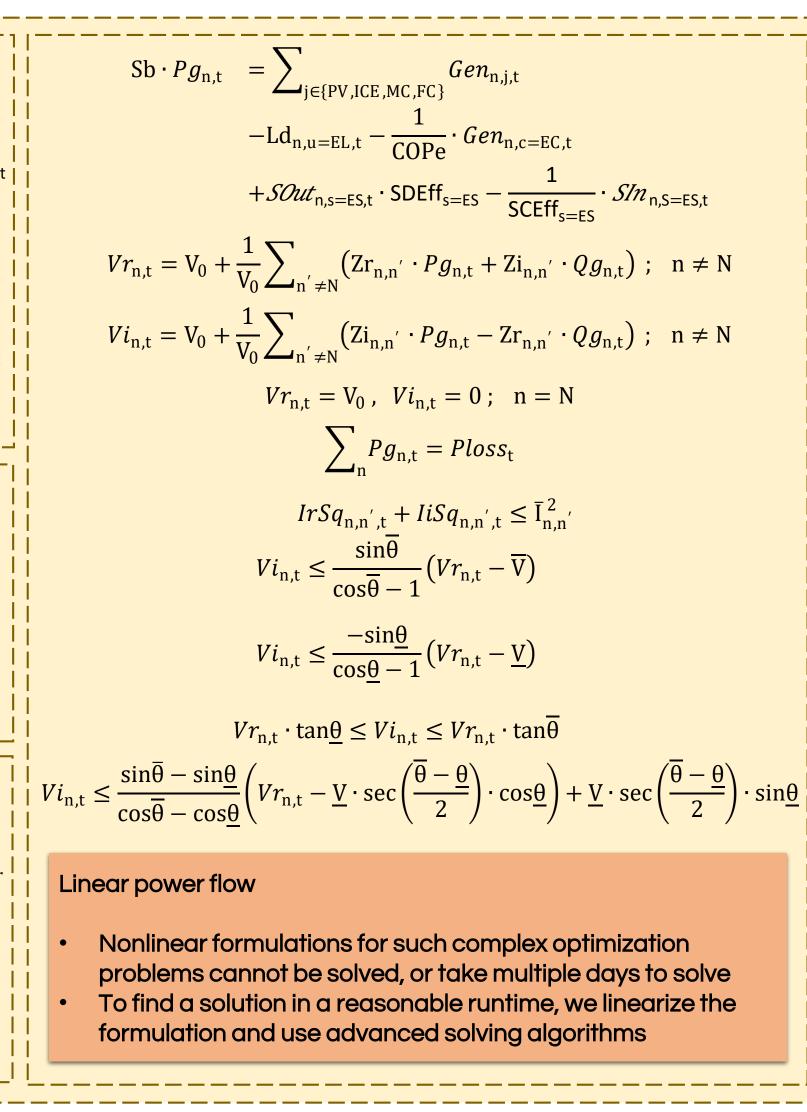
### Remote Off-grid Microgrid Design (DOE, NETL)

**Objective:** Development of an advanced optimization-based design support tool for microgrids in remote locations, aimed for utilities, research institutions, and industry

Selected features: Secure design against contingencies; multi-node design; interactive interface with GIS front-end

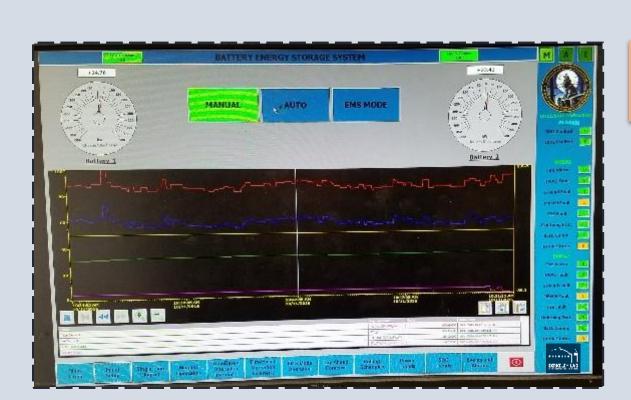






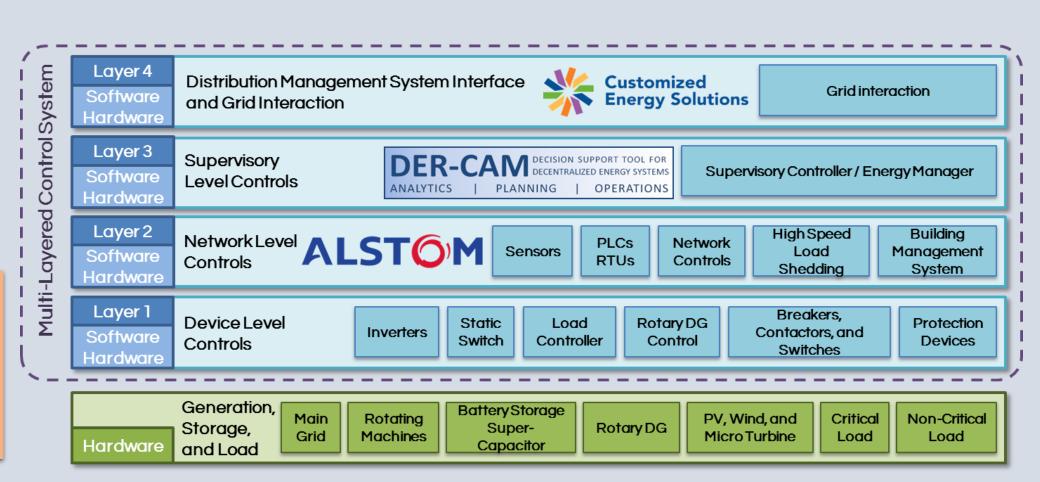
### Supervisory Microgrid Control System for Military Installations (DOD)

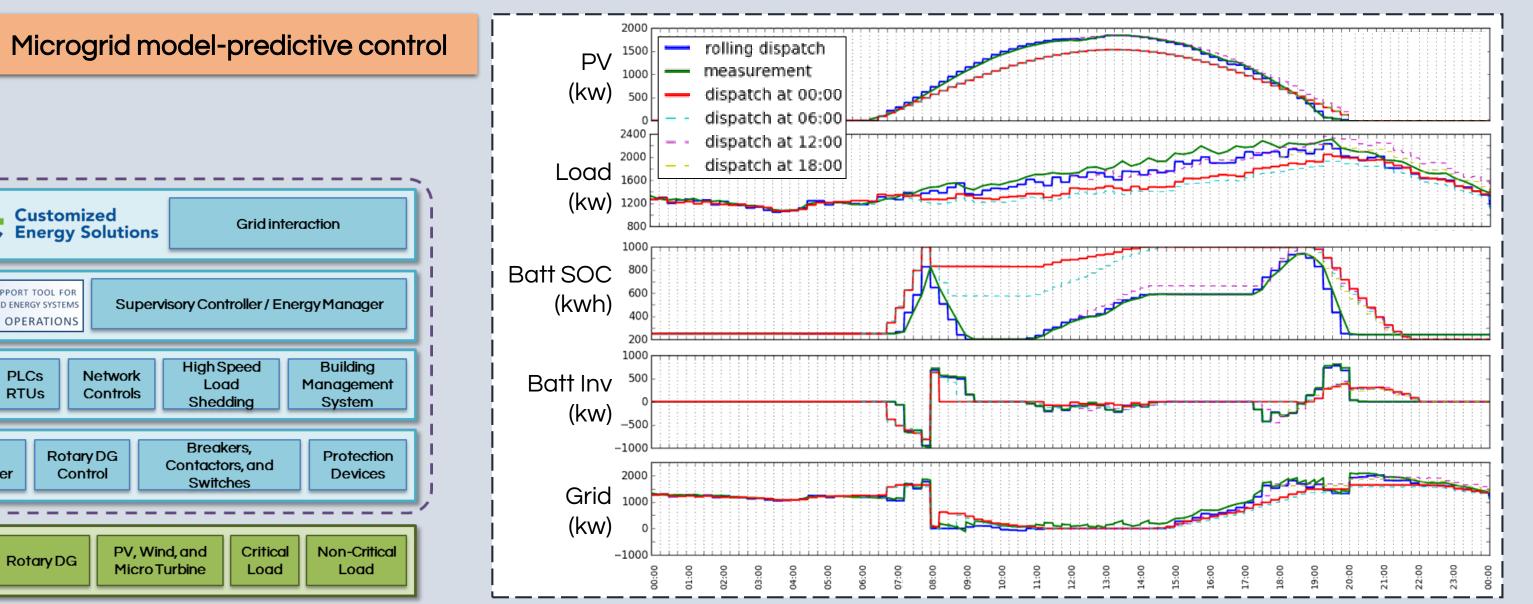
Objective: Develop and demonstrate a multi-layer control architecture for renewable-intensive microgrids



Test control center at Fort Hunter Liggett

Developed multilayered control, became the basis for IEEE 2030.7 Standard for microgrid controllers









**ENERGY STORAGE & DISTRIBUTED RESOURCES DIVISION**